

VIRGINIA GIS REFERENCE BOOK

General Application Name: County Executive & Board of Supervisors

Product / Service / Function Name: Demographic Analysis

P/S/F Description:

The term “demographics” describes the characteristics of human populations and segments of the population. These characteristics can include age, gender, education level, religion, and income level. Demographic analysis involves using statistics to summarize these characteristics in order to identify trends or patterns that are occurring in the population. Demographic information is used in a number of ways. From city planning to business marketing, being able to describe and target a certain group of people allows for better and more efficient decisions to be made.

The study of demographics can be easily integrated with geography to study the distribution of human characteristics over a given time and space. GIS is the ideal tool to help planners and others reveal interesting correlations with other aspects of the human and natural environment, such as land use patterns, infrastructure needs, and available housing.

Product / Service / Function

1. Spatial Data

Minimum Requirements

General Description	Data Layer
Demographic Data	Census Tracts
	Census Block Groups
Socio-Political	Municipal boundaries
	Zoning districts
	Land Use
Planimetrics/Base Map	Street Centerlines
	Orthophotography

Optional Enhancements

General Description	Data Layer
Community	Schools
	Bus Stops
	Parks/Recreation
	Crime incidents
	Retail Centers
	Business Parks
	Hospitals
	Fire Stations
	Voting Districts
	State/Local/Federal Representative Districts

	Public Transportation
Utilities	Sewer
	Water
	Sewer
	Storm water
	Gas
	Electric
Transportation	Railroads
	Parking Lots
	Airports

2. Attribute Data

Minimum Requirements

General Description	Field Name
Demographic Data	Gender
	Age Class
	Households
	Ethnicity
	Marital Status
	Children data
	House Units
	Salary information
	Education
	Religion
Zoning	Zoning District
Land Use	Classification

Optional Requirements

General Description	Field Name
Demographic Data	Project Specific Information (depends on what is being studied)
Community Data	Project Specific Information (depends on what is being studied)

3. Data Acquisition Options (integrated with VBMP digital orthos)

Most of the information required for demographic analysis can be obtained from the US Census Bureau through its TIGER line files and other statistical data. The TIGER line files are in GIS format and includes various census boundaries like blocks and tracts. The demographic information for each county is released separately as “Summary Files” in a database/spreadsheet format which can be related to the block/tract data GIS layer based on a common ID number. Demographic data is available at <<http://factfinder.census.gov/servlet/BasicFactsServlet>> and the boundary files can be downloaded from <<http://www.census.gov/geo/www/tiger/index.html>>. Optional demographic information may need to be collected by agencies that focus on a specific

segment of the population.

Other data such as utilities, buildings, land use, streets, community facilities, etc. are typically maintained at the county or city level. Street centerline data layers of varying qualities can be obtained from a number of vendors. The market is relatively competitive, and prices will vary with quality of the data. Relevant vendors that provide this kind of spatial data on a regional and national scale include: NAVTECH <www.navtech.com>, GDT <www.geographic.com>, and TeleAtlas <www.teleatlas.com>.

For demographic studies, using the VBMP orthophotos as a base layer can enhance the viewer's understanding of the data. Orthophotos provide a "bird's eye view" of the study area, which can help the user visualize the physical location in conjunction with the demographic data being displayed.

4. Data conflation Options (integrated with VBMP digital orthos)

Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically "corrected" through geometrical and rotational transformations so that the different layers can be overlaid on one another. Also called "rubber-sheeting," this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation.

After the TIGER census data is received from the US Census Bureau, it must be converted from TIGER format into a GIS data format, such as a shapefile. Most standard GIS software has out-of-the-box functionality to convert TIGER data. The converted TIGER data (e.g. blocks, tracts, etc.) must also be reprojected to match the VBMP orthophoto coordinate system. This ensures that the demographic data will match the VBMP orthos as well as the rest of the GIS data, such as centerlines.

5. GUI / Programming options

There are a few options for developers of a GIS-based demographics application. Two possibilities for development are:

- Standard GIS desktop software that can be customized to the user's needs
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS software package often requires a significant amount of training and customization. Whereas the initial cost may be lower, the time invested in learning these solutions may generally increase the overall expense of implementation. However, standard GIS software packages deliver more robust data integration, analysis, and cartographic capabilities than do other specialized commercial applications. They have a greater user support infrastructure that allows users to overcome problems quickly. Options for using an existing,

industry-standard GIS software application that can be customized for demographic analysis include those listed in the following table:

Standard GIS Software Vendors:

<i>Vendor</i>	<i>Software</i>	<i>Web Address</i>
ESRI	ArcView 3.x	http://www.esri.com
ESRI	ArcGIS 8.x	http://www.esri.com
MapInfo	Professional 7.0	http://www.mapinfo.com
Intergraph	GeoMedia 5.0	http://www.intergraph.com/gis
Autodesk	Map 5.0	http://www.autodesk.com

The second option for developing and implementing a GIS-based demographic analysis application is to contract a consultant. This option makes certain that a product will fulfill a jurisdiction's requirements. A consultant will be able to develop an application that works with the wide range of hardware and software that are currently in use within local governments within Virginia. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

A demographics analysis application would prove to be very useful to several different departments and agencies within a municipality. There are several possible functionalities for a demographic analysis application within a local government:

- Locating where school-aged children live to create the most efficient bus routes
- Identifying urban renewal projects
- Plotting crime incidents versus race/income distribution in a city in order to develop programs that help reduce crime levels
- Select a location for a new business based on the demographics of its targeted clientele
- Analyze locations of cancer patients compared with a certain environmental factor (e.g. a hazardous waste location)
- General demographic analysis of a city's population patterns, which can influence grant monies or Federal funding
- Discover where the population is moving over time to help plan for improvements in transportation and other infrastructure

6. Internet Functionality and options

The Internet has proven itself as a viable solution for local governments to centralize the maintenance and management of services and data. As more local governments are implementing Web-based solutions, they are finding that the Internet requires them to change the nature of an application or its usefulness. Through the flexibility of an Internet solution, software can be easily updated, and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

While desktop applications are mainly for staff and "power users," an application can be deployed on the Web to allow greater access to this information for the community. Demographic data is easily deployed on the Internet and can be a useful tool. Users would be able to create their own maps of specific demographic parameters of interest for the municipality. Also, the results of any GIS-based demographic analysis studies can be put online. GIS software vendors have products that can be customized in-house or by a consultant to provide Web GIS applications on

the Internet, over an intranet or via wireless network. The table below shows GIS vendors and their Internet mapping solutions.

GIS Internet Solutions

Vendor	Internet Software	Web Address
ESRI	ArcIMS	http://www.esri.com/software/arcims
MapInfo	MapXtreme, MapX	http://www.mapinfo.com
Intergraph	GeoMedia WebMap	http://www.intergraph.com/gis/gmwm
Autodesk	MapGuide	http://www.autodesk.com

7. Technical Requirements

Minimum Technical Requirements

At its most basic level, a demographic analysis application can be used on a single, stand-alone workstation. This workstation would have a hard drive that stores all of the spatial data layers and other associated tabular data. A typical workstation running off-the-shelf software should have the following minimum specifications:

Processor:	Pentium 3, 450 MHz
RAM:	128MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19"
Floppy Drive:	3.5"
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional
Printer:	8x11 office-grade color printer

Optimum Technical Requirements

A more intensive demographic analysis system may require multiple components, including servers and desktop workstations. Example specifications of the necessary equipment are listed below:

Server

Processor:	Min. 2x Processors, 1.7 GHz, 512K cache
RAM:	Min. 2x 512MB RIMMS
Hard Disk:	Min. 2x 80GB +RAID
Monitor 1:	19"
Floppy Drive:	3.5"
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

Workstation

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19"
Monitor 2:	17"
Floppy Drive:	3.5"
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

Other Components

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

8. Administrative/Management Requirements

At the beginning of the application development, the assigned project manager from the particular municipality should consider completing some, if not all of the following tasks that relate to the administrative requirements of a demographic analysis application:

- Determine, with or without the assistance of a consultant hired to develop the system, the preliminary vision and goals of the project.
- Coordinate an initial meeting with the stakeholders (i.e. the Board of Supervisors, City Council, planning department, school board, environmental agencies, public works department, transportation agencies, etc.) where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the decision-makers aware of the progress of the project.
- Develop a basic understanding of the available precedents in the region/state and research the available technologies that can be applied to the project.

Upon project completion, a basic GIS-based demographic analysis application will require very little administrative support. Administrative tasks may include loading or upgrading new versions of the software or patches, providing for constant data flow, and maintaining yearly support contracts on the hardware and software. However, once the system becomes distributed as an enterprise solution to many users throughout a department or deployed on the Internet, there are various other management requirements that need to be fulfilled on a weekly or monthly basis.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone needs to maintain contact with the technology personnel that maintain these systems.
- The manager needs to put into place training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.

9. Costs:

Hardware	Typical Unit Cost
Minimum Workstation	\$2,000
Optimum Workstation	\$3,200
Laptop	\$2,400
Web/FTP Server	\$8,500
Database Server	\$12,000
Data Warehouse Server	\$18,000
Backup Server	\$5,800
Printer (8x11 color)	\$700
Printer (8x11 b/w production)	\$2,000
Plotter	\$12,000
Tape Library	\$5,000
UPS	\$700
Scanner	\$1,500
Handheld	\$300-\$700

Software (all prices included license)	Typical Unit Cost
Standard GIS desktop software	\$700-\$10,000
Customized desktop vendor solution	\$5,000-\$15,000
Web-based vendor application	\$15,000-\$25,000
Customized web-based vendor solution	\$20,000-\$60,000

Miscellaneous	Typical Unit Cost
Training - focused vendor training (per person)	\$700-\$1,000
Training - general GIS	\$700-\$1,200
Licensing-desktop	\$100-\$500
Licensing-webapp (1st CPU)	\$7,500-\$12,000
Maintenance (per year)	\$8,000-\$15,000

10. Standards / Guidelines Summary

- Consider creating, customizing, or purchasing an application that integrates demographic analysis functions with other municipal GIS application, such as land use planning or zoning. This is most likely a more cost-effective solution, rather than having separate applications.
- A GIS-based demographic analysis application should be built so that non-technical personnel can be trained to use the system.

- A Web GIS application should be even more simplified for the average citizen to use to view their location's demographic profile.
- Acquire input from all departments who will be involved in funding and/or utilizing the application before proceeding with the application design.
- Maintain data in the VBMP standard coordinate system.

11. Startup Procedures/Steps

There should be a minimum of eight steps involved with developing a GIS-based zoning enforcement application, after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, GIS data, and personnel needs. It should include interviews of key individuals throughout the local government agency and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those interviewees that have little prior understanding of GIS. A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for a GIS-based demographic analysis application in the following areas: personnel needs, spatial data development needs, applicable spatial analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed system. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application or system.

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Analytical techniques that the application/system provides the user for analysis
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system

The third task should be to compile or develop spatial data that can be used by the evolving application. Data can be gathered from a number of online sources, as well as county/city departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document and can be acquired through the methods described in Section 3 of this document.

On completion and acceptance of the functional requirements document and the development of the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The

local government agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the local government agency remains a part of the development process throughout the project timeline.

When the application is nearing 100% completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful implementation of a GIS-based demographic analysis application is ongoing technical support. The local government agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of an application.

22. Estimated time line and/or implementation (stand alone) schedule

Phase	Duration
Needs Assessment	1 month
Data Development	3-8 months
Customized Application Development	3-5 months
User Training	½ month
Plan for Future Development	¼ month
Ongoing Support	3 months

23. Best Practice Examples in Virginia

Prince William County
Geographic Information Systems
4379 Ridgewood Center Drive
Prince William, VA 22192
(703) 792-7193
<http://www.pwcgov.org/demographics/default.htm>

Hanover County
Planning Department
7516 County Complex Road
PO Box 470
Hanover, VA 23069
804-365-6171
<http://www.co.hanover.va.us/planning/demog.htm>